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Research on the Change of GDP Growth, Monetary Growth and Price Index based on VAR and IRF

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ARTICLE INFO	ABSTRACT

In this paper, we use the macro data from the first quarter of 2001 to the first quarter of 2015, through vector autoregressive (VAR) model, Granger causality analysis, impulse response function (RFI) and variance decomposition analysis of quantitative analysis methods, to research on the relationship among China's real growth variation of gross domestic product(GDP), Money supply growth rate and consumer price index. We find that the money supply growth has impact on China's real growth variation of GDP in short-term, but there is no long-term significant effect. Economic growth is the main factor to promote the consumer price index growth, money growth is not the main factor driving the change in the price index. China's currency growth is affected significantly by the change of the economic growth.

1. Introduction

From 1984, the people's Bank of China began to exercise the functions of the central bank and the Chinese government's intervention on economy has been changing from the simple administrative intervention to adjustment of the monetary policy based on market regulation. However, the international economic environment is becoming more and more complex and China is in the special period of economic restructuring, the effect of China's monetary policy does not reflect the intuitive and simple predictability. And along with the explosive growth of the global virtual economy, the Proportion that virtual economy in China's economic aggregate also increased significantly [1]. The development of virtual economy makes the operating mechanism of monetary policy more complicated. In some extent virtual economy dilutes the

effects of monetary policy on the real economy. In 2008, in response to the global financial crisis, the Chinese government launched a series of economic stimulating plan as well as the loose monetary policy to rescue the market. However, results is that some money is directly absorbed by virtual economy, leading to the real estate and related industries, stock prices, but the benefit on real economy is limited [2-4]. It is an urgent question to be solved that how Chinese monetary policy affects Chinese economy.

For more than a decade, the inflation of China has been maintained at a high level. At the same time, the growth M2 is nearly ten times. General view is that monetary policy caused persistent high inflation, namely inflation dynamics are completely explained by expansionary monetary policy decision. However, the debate whether the fact is that logic has never stopped. Based on the view

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of general dynamic equilibrium, currency issuance will change the expectation of consumers and manufacturers on future inflation, thus it affects household consumption and pricing of manufacturers. The former has the impact on the demand side, the latter affects the supply side. Monetary policy will have an impact on the macro economy by changing the expectation. So to understand the monetary policy, the basic starting point is to understand people's expectations of inflation formation process [5-7]. From the beginning of the first quarter of 2010, China's GDP growth rate continuous to decline. With drastic slowdown in the economic growth of our country recently, the market orientation of future monetary policy is debate endlessly, which focus on whether monetary policy should be fully relaxed.

In view of the above questions, this paper will have empirical analysis on the variation of China's economic growth, money supply m2 and CPI, and to explore how our country should control the money supply.to balance relationship between economic growth and rising prices.

2. Model Building and Data Processing

2.1 Model Constructing

(1) The vector auto regression (VAR) is commonly used for prediction of time series system and analysis of stochastic disturbances affecting the system variables the benefits of VAR model is that it doesn't need to make assumptions that which variables in the model of is endogenous or exogenous. It directly considered the relationship between the various economic variables of time series. The matrix form of the model VAR is as follows:

$$X t=A0 +A1X t-1 +… +ApXt-P +B0 Zt+B1Zt-1+… +BrZt -r+εt \qquad (1)$$

The A0 is the intercept, which is an n*1 vector. A1, … , Ap is the n*n coefficient matrix, which is related to the lag value of endogenous variable and its current value. B0, … , Br are n*m coefficient matrix of current value and lag value of exogenous variable and current value of endogenous variable. εt is error, which is a n*1 vector.

(2) Granger causality test is an attempt to analyze the causal relationship between the variables, which is developed by the economist. Clive W. J. Granger. In the case of time series, Granger causality between the two economic variables X, Y is defined: if X,Y have been included in the model a, which use the past information of variables X and Y to predict the future value of variable y, the model b only includes the past information of variables Y. If the results of model a are superior to that of b, X is the Granger cause of the variables Y.

(3) The impulse response function (IRF) of vector autoregressive model (VAR) model is offen used to explore response of the system to newborn innovation of a variable. When the disturbance of a variable is changed in period t, it will produce a series of chain reactions through dynamic relationship among variables in the model after period t. The impulse response function will describe the dynamic response of the system to the new disturbance [8-11].

(4) The forecast error variance decomposition of vector autoregressive model is used to do analysis of the contribution rate. The impulse response function is to track the system impact effect of a variable in the model. And variance decomposition is that squared error of the system is decomposed into contributions of each variable to the system impact, it is the contribution ratio of impact each variable accounted for the total contribution. In 1980, Sims proposed the variance decomposition method, which was used to quantitatively analyze the relationship between variables.

2.2 Variable Selection and Data Processing

2.2.1 GDP Growth Variation (d2rgdp)

Due to nominal GDP contains the inflation factors, this paper is going to analysis monetary policy on the economy of real growth effect, so firstly, removing the effects of inflation. The calculation method is rgdp=gdp/ (1+CPI). For quarterly data, we often need to adjust it and remove seasonal factors before using it. In China's real GDP growth, due to the first quarter includes the Spring Festival, it is generally low in the first quarter. If we directly compare the data of second quarter with that of first quarter, we will overestimate the growth rate of second quarter GDP; if we directly compare the data of the first quarter with that of the fourth quarter, we will underestimate GDP growth rate in the first quarter. In short, the data which contains the seasonal effect cannot be directly carried out. From the graph 1, we clearly see that there is a clear seasonal effect on the line of the actual GDP. In this paper, the regression analysis method is used to adjust the seasonal effect. First we generate seasonal variables, then use the GDP time series to do regression with these variables, the residuals is the sequence after seasonal adjustment. Rgdp represents real sequences which don't exclude seasonal effect, and mv_gdp represents sequences which excludes seasonal effect. We can see clearly that GDP series become more smoothed after seasonal Adjustment.

2.2.2 Consumer Price Index (CPI)

The direct effect of inflation is the price rise of goods. The price rise causes the reduce on true values of the public

revenue and decline living standards. In view of this, this article choose the CPI as the measure of inflation which people generally pay close attention to.

2.2.3 Broad Money Growth Rate (inr_m2)

The ultimate goal of monetary policy implemented by the central bank is to control the development of the macro economy. The key to the success of monetary policy depends largely on the choice of intermediate targets. The choice of intermediate target is not unified. According to the classical monetary theory, the intermediate target of the monetary policy is the interest rate and the money supply. Due to the current interest rate of our country have not yet been fully liberalized, interest rate formation mechanism is not perfect, the money supply is an important tool of monetary policy. So in this paper, we use the growth rate of broad money supply to represent monetary policy [12-13].

2.2.4 Stationary

The first restrictive condition to use VAR model is to ensure that the time series are stationary. Therefore, this paper will test the time series variables through the unit root (ADF) test. table 1 is the results that we get.The consumer price index CPI and seasonal growth rate of M2, inr_m2 is stationary time series, but GDP is not the stationary time series. We make the first order difference with it, the increment of GDP is still not stable.We make the second order difference with mv_gdp, we obtain the stationary time series, namely GDP growth variation.

2.3 Model Analysis and Data Preprocessing

2.3.1 Determine the Lag Order of the Model

In order to use the VAR model to analyze the relation-

ship among the GDP growth variation (d2rgdp), consumer price index (CPI) and broad money growth rate (inr_m2), we first need to determine the order of the VAR model according to the information criterion. The table 2 shows various information criteria which are used to select the number of lag order, but they are not consistent. According to the simple SBIC criteria, there is no lag effect, According to the LR, we should select 10 lag order; according to the FPE, AIC, HQIC criterion, we should select 6 lag order. We finally choose the FPE, AIC, HQIC criteria as the standard, and use the VAR model with 6 lags behind.

2.3.2 Test Validity of the Model

Table 2

lag	d2rgdp		inr_m2		CPI		all	
	chi2	Pro	chi2	Pro	chi2	Pro	chi2	Pro
1	11.570	0.009	1.603	0.659	20.917	0.000	45.02666	0.000
2	4.572	0.206	12.142	0.007	0.873	0.832	27.13711	0.001
3	17.821	0.000	11.114	0.011	6.238	0.101	41.86853	0.000
4	1.027	0.795	8.716	0.033	30.006	0.000	46.04701	0.000
5	6.956	0.073	3.979	0.264	10.292	0.016	26.84189	0.001
6	9.215	0.027	1.743	0.628	12.084	0.007	34.85924	0.000

Due to using a lag period of 6 and three variable VAR model, model, the coefficients of model are too many that cannot be explained with economic implications. And later we will do impulse response function analysis and Granger causality test, so here we only test the joint significance. Table 3 shows that although the coefficients of the some order in single equation are not significant, but as a whole of three equations, the coefficients are highly

Table 1

lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	-504.212				474433	21.5835	21.6279	21.7016
1	-497.734	12.957	9	0.165	528816	21.6908	21.8685	22.132
2	-481.635	32.179	9	0	393087	21.3887	21.6998	22.2154
3	-469.011	25.248	9	0.003	341355	21.2345	21.6789	22.4155
4	-453.385	31.252	9	0	263894	20.9526	21.5303	22.4878
5	-442.021	22.729	9	0.007	248502	20.8519	21.563	22.7415
6	-423.177	37.687	9	0	173906	20.4331	21.2774	22.6769
7	-415.129	16.097	9	0.065	198217	20.4736	21.4512	23.0716
8	-408.531	13.195	9	0.154	249583	20.5758	21.6868	23.5282
9	-405.752	5.559	9	0.783	389083	20.8405	22.0848	24.1471
10	-391.566	28.372*	9	0.001	400757	20.6198	21.9975	24.2808
Selection-order criteria Sample: 11-57 Number of obs=47								

significant.

Table 3

	Prob>chi2	Prob_skewness	Prob_kurtosis
d2rgdp	0.188	0.096	0.452
CPI	0.315	0.134	0.810
inr_m2	0.004	0.007	0.047

Checking whether the residuals in the model obey normal distribution, the results are shown in table 5, so we can accept the original hypothesis at the 5% significance level, that the disturbance of three variables obeys normal distribution. We further examine the stability of the VAR system (for the stationary process). All eigenvalues are in the unit circle, so the VAR is stable. But some eigenvalues is very close to the edge of the unit circle, which means that some shocks have strong continuity.Through the examination of random and normal distribution of the residuals, and system stability of the VAR model, we can make sure that 6 lag order VAR model can be well used to analysis the The relationship among the GDP growth variation (d2rgdp), consumer price index (CPI) and broad money growth rate (inr_m2).

3. Empirical Analysis

3.1 Grainger Causality Analysis

Table 4. Grainger causality Test

Equation	excluded	chi2	df	Prob
d2rgdp	d2rgdp	21.437	6	0.002
	CPI	17.345	6	0.008
	inr_m2	59.086	12	0.000
CPI	d2rgdp	33.715	6	0.000
	CPI	10.658	6	0.100
	inr_m2	48.049	12	0.000
inr_m2	d2rgdp	21.453	6	0.002
	CPI	1.7438	6	0.941
	inr_m2	28.386	12	0.005

The table 4 shows: when we set GDP growth variation (d2rgdp) as explanatory variables in the equation, the Chi2 which corresponds to the CPI is 21.437, the corresponding p value is 0.002. So we think inflation is a Granger cause of the GDP growth variation. Corresponding values of the chi2 of Inr_M2 is 17.345 and corresponding P value is 0.008. So we think monetary growth rate (Inr_M2) is also

a Granger of the GDP growth variation.

When we set consumer price index (CPI) as explanatory variables in the equation, the Chi2 which corresponds to GDP growth variation (d2rgdp) is 33.72., the corresponding p value is 0.000. So we think that GDP growth variation (d2rgdp) is a Granger cause of the consumer price index (CPI). The corresponding p value of broad money growth rate (inr_m2) is 0.10. So at the 10% significance level, we think that broad money growth rate (inr_m2) is not a Granger cause of the consumer price index (CPI).

When we set the broad money growth rate (inr_m2) as explanatory variables in the equation, the Chi2 which corresponds to GDP growth variation (d2rgdp) is 21.45., the corresponding p value is 0.002. So at the 1% significance level, we think that GDP growth variation (d2rgdp) is a Granger cause of the broad money growth rate (inr_m2). The corresponding p value of the consumer price index (CPI) is 0.94. So at the 10% significance level, we think that the consumer price index (CPI) is not a Granger cause of the broad money growth rate (inr_m2).

3.2 Pulse Function Result Analysis

Through the impulse response function, we know that monetary growth in the short term will cause continuous fluctuations in the rate of economic growth. It can accelerate economic growth in short-term, the effects of the broad money growth rate (inr_m2) on the economic growth rate was not significant in long-term [14-15].

The broad money growth rate (inr_m2) only causes fluctuations on consumer price index (CPI). However, it does not have a significant impact on the mean of CPI. This paper explain this phenomenon from two aspects: the one is that the majority of market participants predicted the money supply almost correctly. The other is that China's money supply is used to regulate the economy, so currency supply, economic development demand and the market supply of goods is consistent.
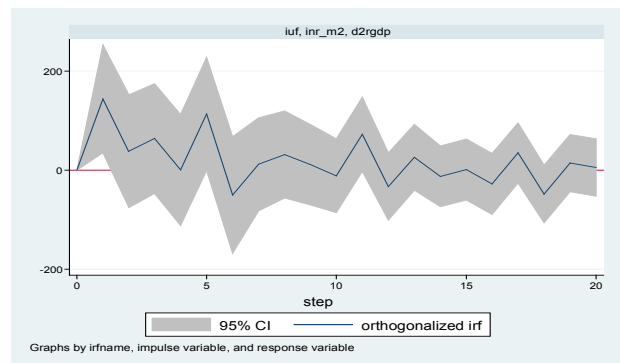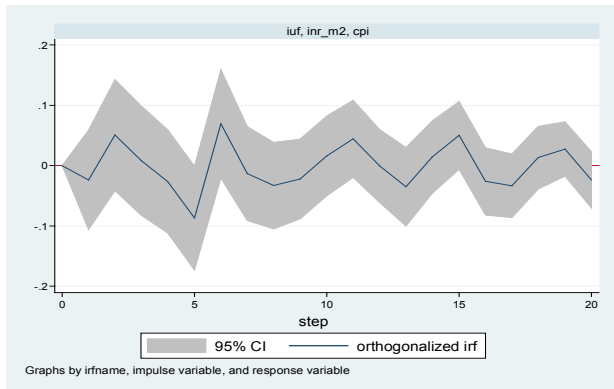

Figure 1

Figure 2

The change of China's economic growth rate (d2rgdp) will cause the sharp fluctuation of the consumer price index (CPI). To a certain extent, the fluctuation shows a periodic trend. Market participants reflect optimism and pessimism. When economic growth accelerate, market participants are generally optimistic, consumer spend more, short-term price rise. Then consumers find economic growth doesn't meet expectations, and reduce consumption, the demand decrease, price index rise slow down or decline.

3.3 The Forecast Error Variance Decomposition of VAR

As table 4 shows, when we make a quarterly forecast of the GDP growth variation (d2rgdp), the forecast variance is completely from d2gdp. Even if in the 20 previous forecast, there are still 67% of the forecast variance from its own. This means that consumer price index (CPI) and broad money growth rate (inr_m2) are not factors that influence d2gdp. With the increase of the lag order, the proportions from CPI and inr_m2 are higher and higher. It means that consumer price index (CPI) and broad money growth rate (inr_m2) both have a significant lag effect on GDP growth variation [16-17].

As table 4 shows: When we make a quarterly forecast

Table 5

Step	1.fevd	2.fevd	3.fevd	1.fevd	2.fevd	3.fevd	1.fevd	2.fevd	3.fevd
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	1.000	0.000	0.000	0.117	0.883	0.000	1.000	0.000	0.000
2	0.881	0.010	0.109	0.362	0.634	0.004	0.881	0.010	0.109
3	0.843	0.046	0.110	0.365	0.612	0.023	0.843	0.046	0.110
4	0.765	0.116	0.119	0.364	0.613	0.023	0.765	0.116	0.119
5	0.780	0.110	0.109	0.345	0.628	0.027	0.780	0.110	0.109
6	0.746	0.105	0.148	0.326	0.603	0.072	0.746	0.106	0.148
7	0.740	0.107	0.153	0.313	0.592	0.095	0.740	0.107	0.153
8	0.729	0.126	0.146	0.310	0.601	0.090	0.729	0.126	0.145
9	0.717	0.136	0.146	0.320	0.590	0.091	0.717	0.136	0.147
10	0.719	0.135	0.146	0.330	0.578	0.091	0.718	0.135	0.146
11	0.706	0.151	0.144	0.342	0.568	0.090	0.705	0.151	0.144
12	0.694	0.149	0.157	0.341	0.561	0.098	0.694	0.149	0.158
13	0.694	0.149	0.157	0.331	0.578	0.091	0.694	0.149	0.158
14	0.694	0.148	0.158	0.330	0.574	0.096	0.694	0.148	0.158
15	0.686	0.158	0.156	0.331	0.566	0.096	0.686	0.158	0.156
16	0.679	0.167	0.154	0.328	0.571	0.106	0.680	0.167	0.154
17	0.678	0.166	0.156	0.321	0.565	0.107	0.678	0.166	0.156
18	0.678	0.165	0.158	0.324	0.566	0.111	0.678	0.165	0.158
19	0.674	0.163	0.163	0.323	0.566	0.111	0.674	0.163	0.163
20	0.670	0.168	0.162	0.325	0.563	0.112	0.670	0.168	0.162
	1.irfname=iuf,impulse=d2rgdp,and response=d2rgdp			1.irfname=iuf,impulse=d2rgdp,and response=CPI			1.irfname=iuf,impulse=d2rgdp,andresponse=d2rgdp		
	2.irfname=iuf,impulse=CPI,and response=d2rgdp			2.irfname=iuf,impulse=CPI,and response=CPI			2.irfname=iuf,impulse=CPI,and response=d2rgdp		
	3.irfname=iuf,impulse=inr_m2,and response=d2rgdp			3.irfname=iuf,impulse=inr_m2,and response=CPI			3.irfname=iuf,impulse=inr_m2,and response=d2rgdp		

of the consumer price index (CPI), there are 88.32% of the forecast variance completely from its own. In the 20 previous forecast of CPI, there are still 56% of the forecast variance from its own, but 32.52% of the forecast variance come from d2rgdp, only 11.21% of the forecast variance is from inr_m2. This means that the GDP growth variation is the significant factors that influence the CPI, but broad money growth rate (inr_m2) is not a main factor that influence CPI. With the increase of the lag order, the proportions from d2rgdp and inr_m2 are higher and higher. It means that d2rgdp and inr_m2 both have a lag effect on CPI.

As table 4 shows: When we make a quarterly forecast of the broad money growth rate (inr_m2), there are 77.81% of the forecast variance completely from its own. In the 20 previous forecast of CPI, there are still 51% of the forecast variance from its own, but 42.73% of the forecast variance come from d2rgdp, only 5.92% of the forecast variance is from CPI. This means that the GDP growth variation is the significant factors that influence the the broad money growth rate (inr_m2), but the CPI is not a main factor that influence the broad money growth rate (inr_m2). With the increase of the lag order, the proportions from d2rgdp is higher and higher. It means that d2rgdp have a lag effect on inr_m2.

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